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I, LEANNE MYNOTT, MANAGER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003906964 for a patent by ANOVA SOLUTIONS PTY LTD as filed on 17 December 2003.

WITNESS my hand this
Seventh day of January 2005

LEANNE MYNOTT
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AUSTRALIA

Patents Act 1990

ANOVA Solutions Pty Ltd

PROVISIONAL SPECIFICATION

for the invention entitled:

"Novel root and water management system"

The invention is described in the following statement:

TITLE

"NOVEL ROOT AND WATER MANAGEMENT SYSTEM"

FIELD OF THE INVENTION

THIS INVENTION relates to a novel pot for use with plants and an arrangement and method for delivering a liquid, particularly water, to a plant-growing medium and removing excess liquid from the medium. The device and method are particularly well suited to use in a commercial and/or nursery setting but are not so restricted and may be useful for an individual plant and/or in a domestic context.

BACKGROUND OF THE INVENTION

Most container grown plants, particularly production grown pot plants, are watered from above by an arrangement which may include one or more of sprinklers, drippers, and/or a handheld hose. Increased costs of providing water and also attempts to better stabilise the water content of pots has led to growing interest in application of bottom watering systems. Bottom watering is being widely practiced in the production of bedding plants, but its wider adoption will be highly likely to occur with other species as water costs escalate, water use is restricted and point source pollution is penalised.

It has been a long held ambition of serious plant propagators to maximise the effect of watering to thereby improve pot plant culture, not only in terms of reducing water stress but also in terms of automation and resulting labour requirements and efficiency.

The traditional pot plant is formed from a durable polymer or clay product and has a drainage hole or holes arranged peripherally around a lower wall or base. One major problem that arises with the use of such pots relates to water uptake through the holes and drainage of excess water through the holes, both of which are likely to become impeded by root growth. Roots may physically obstruct the passageway provided by the hole or holes. Roots may also concentrate at the base of pot below the potting medium forcing the medium up and out of direct contact with a capillary watering bed in a commercial bottom watering system. This is highly likely to reduce capillary flow rate since the capillary flow rate through a root mass can be reasonably expected to be less than through the growth medium.

A commonly promoted theory is that roots will seek out a source of water

and grow into the source of water to such an extent as to eventually plug the water conduit (see, for example, US Patent No. 5,938,372 to Lichfield). The teaching therefore is that roots will grow preferentially in the direction of incoming water and are positively hydrotropic.

Escaped roots may also mat beneath a pot causing attenuation of the contact between the water delivery mat and plant-growing medium, thereby compromising capillary supply of water to the plant.

SUMMARY OF THE INVENTION

Throughout this specification, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element or integer or group of elements or integers but not the exclusion of any other element or integer or group of elements or integers.

In one aspect, although it need not be the only or indeed the broadest aspect, the invention resides in a pot for growing a plant or plants, the pot comprising:

a side wall having an upper edge forming a mouth;

a bottom wall continuous with the side wall, the side wall and bottom wall defining a chamber to contain a growth medium;

liquid transfer means for transferring liquid between the growth medium and a local environment external to the pot;

wherein:

the liquid transfer means transfers liquid directly to and from a zone spaced from the bottom wall and the liquid transfer means is adapted to limit roots escaping from the pot.

The side wall is preferably continuous and may be formed in any suitable shape including cylindrical, frustoconical or boxlike. The side wall may be formed to any appropriate height. The upper edge may be formed as a lip. The side wall may be imperforate. Preferably, the side wall has one or more apertures formed at a position spaced from the bottom wall. Most preferably, there are a plurality of apertures distributed circumferentially around the side wall and equally spaced from the bottom wall. The apertures may serve as indicators of liquid level in the pot by allowing seepage of liquid externally.

The bottom wall may be formed integrally with the side wall. The bottom wall may include a rib or ridge for reinforcement. The rib may be circular. The bottom wall may be discoid. The bottom wall may be concave. The bottom wall may have at least one aperture formed therein. The at least one aperture may be central. The bottom wall may have a plurality of apertures distributed around its surface area.

The side wall may have one or more basal lateral apertures to provide an escape aperture for excess fluid and roots. Such roots may be easily accessed for air-pruning.

The liquid transfer means may be at least one transfer conduit located through and extending upwardly from the one or more apertures. The one or more apertures may be in or near the bottom wall. The liquid transfer conduit is preferably located in close proximity to or abutting contact to an edge of its corresponding aperture. Preferably, close proximity implies a range of 500 microns or less, preferably 300 microns or less and most preferably 200 microns or less. A particularly suitable range is 100 microns or less and preferably 50 to 70 microns. The liquid transfer means may comprise a plurality of water transfer conduits, each located through a corresponding aperture.

The water transfer conduit may be formed from a porous material. The porous material may be concrete, mortar, rubber, polymer, wood or other suitable material. The preferred material is compacted concrete (1 part cement, 10 parts sand (0.1-0.9 mm fraction) and 1 part water.

The liquid transfer conduit may be formed as a cylinder, a rectangular or square box, a cone, a pyramid or other shape.

The liquid transfer conduit may have a butt section positioned outside the aperture. The butt section may be flared downwardly. The conduit may be waisted to provide a seat for a wall of the aperture. The conduit may have an external coating to enhance elimination or minimisation of a gap between the conduit and corresponding aperture wall. The coating may be plastic, gelatinous or other suitable material.

The conduit may be held in place in the aperture by friction or by resilience in the pot material or the conduit material. Wedges, preferably reverse angle wedges, may also be used. The conduit may be fixed in position by an adhesive providing a bond between the aperture wall and the conduit.

The conduit may be removable from the aperture for subsequent reuse in the same or a different pot.

The conduit may extend outwardly from the bottom wall by any appropriate distance. The conduit may extend upwardly a distance of at least 2mm may be useful but any suitable distance may be chosen to suit particular circumstances. A distance of 1cm to 8cm may also be suitable. The conduit may be formed integrally with the pot. It may be moulded from material that allows liquid to flow into and out of the pot. The conduit may have a raised central area which may also be integral with the pot.

Alternatively, the water transfer conduit may be a flexible fibrous member inserted through an aperture in the pot and extending inwardly and/or upwardly. The flexible fibrous member may preferably substantially occupy the whole of its corresponding aperture. The flexible fibrous member may be partially compressed in the aperture. The preferred aperture may be a slit, slot, circle or similar. The aperture may be formed in the bottom wall or in a side of the pot.

The flexible fibrous member may extend externally below the bottom wall. It may extend under the bottom wall and through a second aperture spaced from a first aperture. The flexible fibrous member may form a wick which extends under the pot and inwardly and/or upwardly through spaced apertures which may be diametrically opposed. The flexible fibrous member may therefore form two alternative but connected water flow pathways for the pot. The pot may include a plurality of such flexible fibrous members. The flexible fibrous member may be formed of spun bond polyester geotextile.

Further alternatively, the liquid transfer conduit may comprise a channel having an inlet aperture in the bottom wall of the pot and an outlet aperture inside the chamber and spaced from the bottom wall with a continuous tunnel between the apertures, the tunnel filled with a liquid transferring material. The liquid transferring material may be growth medium such as peat, coir dust, bark or other timber products or any material that will support plant growth and with acceptable capillary attraction for water. The inlet aperture may include a screen with apertures dimensioned to prevent loss of the liquid transferring material from the tunnel. The tunnel may extend upwardly approximately 1cm to 8cm. The pot may further comprise one or more apertures in the side wall to allow root escape. The apertures may be located basally.

In a further aspect, the invention may reside in a pot suitable for use with a liquid transfer conduit. Additionally or alternatively, the invention may reside in a liquid transfer conduit adapted for positioning in a pot in a manner to resist root escape.

The invention may further comprise liquid supply means. The liquid supply means may comprise a container for holding a reservoir of liquid such as water. Alternatively, the liquid supply means may comprise a capillary mat formed to allow transfer of water or similar liquid from an external source to an area adjacent to the bottom wall of the pot. The capillary mat may be a polyester material or any material that promotes capillary flow. The capillary mat may be positioned on an impermeable barrier. The impermeable barrier may be a plastic sheet. The capillary mat may be covered by an upper sheet or sheets of impermeable material. Preferably, the capillary mat is covered by a series of overlapping impermeable sheets formed to allow inflow of water between the overlapping sections and into the capillary mat. The upper sheet or sheets may have an aperture formed to receive a pot as described above. Preferably, the sheet or sheets have a plurality of apertures formed to receive two or more pots simultaneously.

In yet a further aspect, the invention resides in a system for growing plants, the system comprising a plurality of pots as described above positioned on a liquid supply capillary mat, the mat located between a bottom impermeable sheet and an upper impermeable sheet. The upper impermeable sheet may be formed as a plurality of overlapping sheet members with water inflow channels provided by the overlapping regions.

In yet a further aspect, the invention resides in a method of providing liquid to a growth medium for a plant, the method comprising locating a water conduit member through an aperture in a pot and positioning the water flow conduit such that it is in close or abutting contact with an edge of the aperture so as to resist escape of plant roots. The method may further include the step of positioning a plurality of liquid transfer conduits, each through a corresponding aperture in the pot. The method may further include the step of locating one or more of such pots on a water supply capillary mat. The method may include locating an impermeable barrier beneath the capillary mat and an impermeable or semi-permeable barrier on an upper surface of the capillary mat.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to provide a better understanding of the present invention, preferred embodiments will be described in detail, by way of example only, with reference to the accompanying drawings in which:

FIG. 1 is an exploded schematic view of a first embodiment of a pot of the present invention and a water supply system;

FIG. 2 is a sectional view of an alternative embodiment of a pot of the present invention;

FIG. 3 is a schematic sectional side view of a capillary mat watering system including pots of the present invention;

FIG. 4 is a schematic view of the arrangement of FIG. 3 as seen across a slope of the arrangement;

FIG. 5 is a schematic plan view of the arrangement of FIG. 3 and FIG. 4.

FIG. 6 is a schematic representation of an alternative embodiment of a pot incorporating fibrous wick members.

DETAILED DESCRIPTION OF THE DRAWINGS

The following description is given by way of example only and should not be seen as restrictive on the broad scope of the invention.

Referring to FIG. 1, there is seen a pot 10 formed by a continuous side wall 11 and bottom wall or partition 12. The pot 10 may be formed from any suitable material but it is envisaged the most cost-effective material for commercial use will be a plastic pot as is well known to the art. The pot may be formed with horizontal root escape slots 13 which are provided to allow roots to escape laterally from the pot. In the present arrangement, the roots may then be easily air pruned to retain vigour in the root system while avoiding a mechanical engagement with a capillary mat to be described.

The side wall 11 forms an upper mouth 14 to allow loading of the pot 10 with suitable growth medium for plants. An upper edge 15 of the wall may be formed as a simple termination of the wall or as a ledge, lip or similar. The bottom wall 12 has a peripheral ridge 16 which provides a foot for the pot and some clearance between the bottom wall 12 and an upper barrier 17. The upper barrier 17 may be formed of any suitable material. The barrier may be formed of a permeable material. However, it is

preferred if an impermeable reflective plastic film is used. The barrier 17 may be formed from multiple overlaid sections which provide inlet for water to reach a capillary mat 18. The mat may be formed from any suitable material known in the art. The mat may be formed from spun bond geotextile or any inert non-degradable material that is water absorbent, in which the water is available for plant use. The use of such mats to provide a constant or intermittently supplied liquid nutrient, such as water or a water enriched solution, is well known, particularly in commercial nurseries (Irrigation and Water Technologies Bottom Up System). The capillary mat 18 acts as a delivery means for providing liquid to pots arranged thereon.

The mat is typically sandwiched between the upper barrier 17 and a lower barrier 19. The lower barrier 19 may be formed from any suitable material but a plastic material forms an effective and low cost arrangement.

A liquid transfer conduit in the form of a plug 20 is located through an aperture 21 in the base 12. The plug is formed with a butt section 22 protruding externally of the pot and an upper section 23 which extends inwardly and upwardly into the chamber 24 formed by the side wall 11 and bottom wall 12. The butt section may flare downwardly to provide adjustability to compensate for different sized apertures. Additionally, the weight of the full pot will tend to urge the aperture onto the plug and maintain close apposition of the plug and aperture wall. The plug is formed of a porous material to allow for capillary action and transfer of liquid. The plug may be formed of any suitable material but a particularly effective and cheap composite is a concrete mix. The material may also comprise clay products, wood, plastic or diatomaceous earth. Porosity may be varied to suit different plants and conditions. Porosity in concrete may be varied acording to the proportions of sand, cement and water. In this invention, different plants may be better suited to plugs of different porosity. Alternative materials include rubber, ceramic (fired and unfired), wood, wood products and synthetic polymers.

The butt section 22 is in contact with the capillary mat 18 through an aperture formed in the upper barrier 17.

As a result, presentation of liquid to the capillary mat will result in capillary action drawing liquid through the plug 20 and into the chamber 24 and into a zone which is spaced from and above the bottom wall 12. The zone may extend to the bottom wall but

terminates upwardly of the wall to provide a liquid inlet at a distance into the chamber.

Traditional teaching has held that roots are hydrotropic. Consequent belief is that the roots will migrate to an inlet source of water and ultimately either penetrate through an aperture and block it or compromise the transfer channel from an inlet water source. The inventor has found that while roots in media with water supplied continuously from the bottom are strongly geotropic, they are not at all attracted to an incoming water source. Thus, water input zones above the floor of the pot (eg. at the top of plugs or on the surfaces of tapes) are unlikely to become choked with roots. Consequently, their efficacy as water conduits should continue irrespective of root massing at the base of the pot. The present invention provides a water transfer means which takes water from outside the pot and delivers it remote from the base to thereby avoid problems with the root mass.

The plug 20 may be formed in any suitable shape. Although cylindrical is a convenient and easily formed shape, the plug may be rectangular, triangular in cross section, conical or other shapes. In one embodiment, the plug may be formed with a base having a conical or pyramidal upper section which terminates in a point. The pot, in this instance, may be formed of a material that is penetrable by the point. A series of the plugs may be arranged around the capillary mat and the pots may be simply impaled onto the end of the plug thereby providing suitable insertion. In this application, the pot may be formed of a flexible plastic material and may be a plastic or other similar material bag which is penetrable by the point of one or more plugs.

A top view of the plug is seen at 20A. In this instance, wedges 26 are formed to engage the bottom wall 12 and hold the plug in position. The wedges are also seen in 20B in side view and an exemplary wedge is seen at 26A.

Representative dimensions are shown on the plug 20B. The plug may be formed with a butt diameter of 38mm and an upper section diameter of 34mm. The butt section may be 5mm high and the upper section may be 20mm high. However, it should be understood that these are purely representative only. The plug may extend considerably further into the chamber and the butt may be formed of greater or lesser dimensions. In one alternative embodiment, the plug may form the entire bottom of the pot to thereby replace the bottom wall. A single pot may have two or more plugs which may be of particular assistance in a seedling tray, for example.

The plug may be coated on its lateral surface with a material to ensure obliteration or minimisation of the gap between the plug and the aperture wall. Suitable materials may include plastics, gelatinous materials, waxes or similar.

The present embodiment displays a frictional engagement. It should also be understood that the plug may include positive fixing means such as an adhesive. The plug may be formed with a collar dimensioned and configured to be urged into the aperture and form an intervening barrier between an edge of the aperture and the plug or wall. The plug may have a thread and be screwed into the hole in the base of the pot. A plastic cap with holes may be placed over the plug portion protruding from the bottom of the pot. The cap may assist in resisting plug abrasion. The cap may be of particular use where ports are primarily used for drainage and may be removed to promote capillary water uptake.

While delivery of liquid to the growth medium has been emphasised, it should also be understood that the plug may act as an outlet for liquid in an overwatered pot. Liquid may run from the medium through the plug and externally of the pot. This two-way ability provides great utility in systems where pots are subject to rain exposure or excessive overhead watering. The pot may include one or more indicator apertures in the side wall. These apertures will allow the escape of water during a period of water delivery to indicate a suitable level of water content. The aperture may be sited wherever suitable but is preferably in the upper 70% of the pot or at a level of 3cm higher above the base. A series of apertures located circumferentially around the perimeter side wall may be of particular use. Further, several tiers of apertures may be employed.

Referring to FIG. 2, a pot 30 is seen having a liquid transfer conduit in the form of a tunnel 31 connecting an inlet aperture 32 and an outlet aperture 33. The inlet aperture 32 has a screen arrangement 34 to prevent growth medium from falling through the tunnel. The tunnel 31 filled with growth medium and acts in a similar manner to the plug described in reference to FIG. 1. The inlet aperture 32 is in contact with a capillary mat 35 which is sandwiched between an upper barrier 36 and lower barrier 37. Horizontal basal root escape slots 38 are also provided. Typically, these slots may be formed as slots of 2cm length x 0.5cm height. Needle holes (75 micron diameter), instead of slots may provide a level of aeration and drainage but not the passage of roots.

Advantages of the described embodiments include more predictable water

uptake resulting from less interference arising from the root mass. They may also provide an ability for basal roots to be air pruned. The present arrangement provides less chance for roots to enter into the capillary mat resulting in entanglement and damage to the integrity and function of the mat and also damage to the potted plant when torn from the mat. The arrangement shown will minimise algal growth on mat surfaces which may be of particular problem in high humidity and heat environments. This will result in the absence of a need to use chemicals to prevent algae or root growth wherein the chemicals may be potential environmental pollutants. Further and importantly, pot drainage will be less affected by root blockages and indeed may be unaffected in this regard.

FIG. 3 shows a series of pots 40, each arranged in position with a corresponding aperture 41 aligned to receive plugs 42. The apertures 41 are formed in an upper barrier 43 above a capillary mat 44 and lower barrier 45. This is an across slope view which shows an even and consistent arrangement.

FIG. 4 shows a down slope view of the arrangement of FIG. 3 in which it is apparent that the upper barrier 43 is formed by a plurality of overlapping sheets of material thereby providing water inlet pathways 46 to allow surface water to flow between the layers 47, 48 and into the capillary mat. The overlapping barriers may be formed from strips of reflective plastic film. Irrigation water or rainfall will trickle between the overlapping sheets and be stored in the capillary mat for later uptake by plants. The overlapping sheets will minimise evaporation and the reflective film will normally be dry preventing the growth of algae or weed seed. Any roots emerging from side slots may be air pruned.

FIG. 5 shows a plan view of the barrier and capillary mat arrangement with apertures formed for receiving plugs from the pots.

Although the overlapping sheets provide a preferred embodiment, it is also envisaged that a straight capillary mat may be provided as the upper surface or the upper surface may be a substantially impermeable barrier with holes formed to receive pots. The weight of the pots may create a depression of this barrier leading to collection of top delivered water around the pots and subsequent entry into the capillary mat.

FIG. 6 shows a further alternative embodiment of a pot using fibrous members in the form of wicks.

The pot 60 contains growth medium 61 within side wall 62 and bottom 63. A fibrous wick or tape 64 is routed from below the bottom 63 and through two spaced apertures 65, 66 in the wall 62. The tape 64 extends inwardly, substantially horizontal, to terminate within the body of the medium 61. Of course, the tape may be directed upward or downward if preferred. Additionally, a single tape may enter the pot through only one aperture.

A lower section 67 of the tape 64 is sandwiched between the pot 60 and a capillary mat 68 which is partially covered by a weed mat 69 and supported by an impervious plastic liner 70. The apertures 65, 66 are located approximately 1cm above the bottom 63 but may be positioned at other heights. The tape may insert through an aperture in the bottom. It is preferred that the tape substantially occupies the whole of the aperture.

FIG. 6A shows a bottom view of the arrangement of FIG. 6 which highlights the presence of two parallel tapes 64, 72. The tapes may be angularly deviated and may in fact cross.

FIG. 6B shows a top view with the tapes in place inside the pot 60 and ready for addition of extra medium.

The plugs described may be formed as removable plugs. They may be designed for retrofitting into existing pots. Alternatively, pots with pre-existing apertures may be provided and plugs for subsequent insertion by a grower in the conditions where the present system is desired.

The inventor's discovery that roots are not attracted to an incoming source of water, at adequate moisture levels, is significant. The present invention overcomes the negative effect of blockage of drainage holes with roots and the resultant detriment to water uptake. Using a plug which is relatively small compared to the bottom area of a pot provides the ability to replace the current permeable weed mat with an impervious overlying film with small access holes to the wet underlying geofabric. Such an impervious dry material will prevent most surface evaporation, algal development, weed growth and insect development without the use of any chemicals, currently the mainstay of prevention. Depressions in geofabric resulting from the weight of a pot being concentrated through the plug will provide low points for the entry of water that falls from rain or irrigation on the impervious film and into the underlying geofabric. This will result in

greatly enhanced water saving while retaining the option of a hybrid watering system with water being applied from below or from above but with minimum wastage.

Plugs may be used in bottom up watering systems to facilitate water uptake and to prevent root escape; in overhead watering and rain systems to reduce the rate that water flows out of the pot and to prevent roots penetrating the underlying media. Wells may be used in both bottom up and overhead watering, being effective in reducing root clogging, root lift and too rapid drainage. The plugs are not restricted in height or diameter. The plug could extend to the height of the medium and will usually have permeable sides providing water throughout its length. The plug may be formed as a moisture absorbing plastic formed integrally with the pot. The conduit formed as a well may be adapted to receive a plug. The mesh in this embodiment may be removable or, alternatively, penetrable to allow a choice of arrangements. A number of wells may be formed and may include a shoulder to receive and stop the plug.

The invention also extends to a method of providing water to a pot using a permeable plug, a wick or a well. The wick may be inserted through an aperture which can be formed in the bottom or in a side wall (preferably around 1cm up). The wick may enter the pot at a point up the side wall and spaced from the bottom. The wick may be extended beneath the pot and up through a further aperture providing a continuous dual entry pathway. Preferably, the wick is compressed into the aperture. The wick may be a tape. Several wicks may be used.

The present invention may also have the added advantage of concentrating weight in plugs to provide better contact with the geofabric. Water is used more efficiently with resultant reduction of wastage and also reduced nutrient loss in leachate. The system may provide faster growth and a subsequent shorter growing period while using less quantity of medium to get the same results. Pots may be more stable with concentration of weight in the bottom of the pot with a plug. The plugs may be reusable. Earthworms are unable to enter plugged pots and find difficulty in accessing the channelled pots, depending on the gauge of any mesh present. They will also be excluded from pots with wicks or tapes.

In general, if the upper point or surface of a water inlet conduit is above the zone of basal root concentration, its function in providing capillary flow to the medium

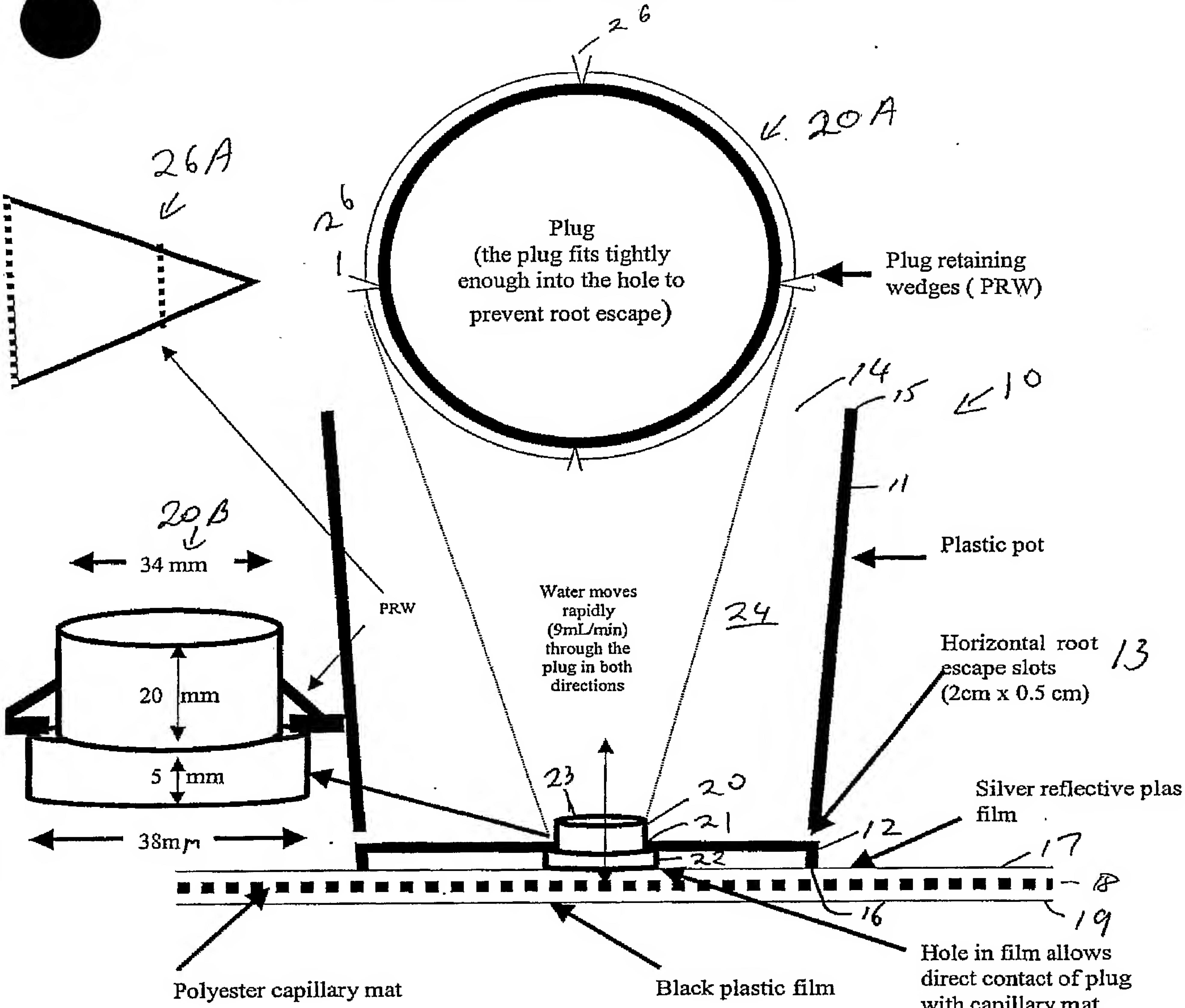
will not be impeded to the same extent as holes formed in the bottom of the pot which are quickly covered with roots.

Throughout the specification, the aim has been to describe the preferred embodiments of the invention without limiting the invention to any one embodiment or specific collection of features. Those of skill in the art will therefore appreciate that, in light of the instant disclosure, various modifications and changes can be made in the particular embodiments exemplified without departing from the scope of the present invention. All such modifications and changes are intended to be included within the scope of the disclosure.

DATED this seventeenth day of December 2003.

ANOVA Solutions Pty Ltd
by DAVIES COLLISION CAVE
Patent Attorneys for the Applicant

Root Control Watering/Draining Plug



Benefits

- More predictable water uptake (much less interference from roots)
- Opportunity for basal roots to be air pruned
- Roots do not enter capillary mat
- No algal growth on mat surfaces
- No use of chemicals to prevent algae or root growth
- Pot drainage not affected by root blockages

FIGURE I

Mal Hunter 7/08/03

Root Control Watering/Draining Well

Root excluding well

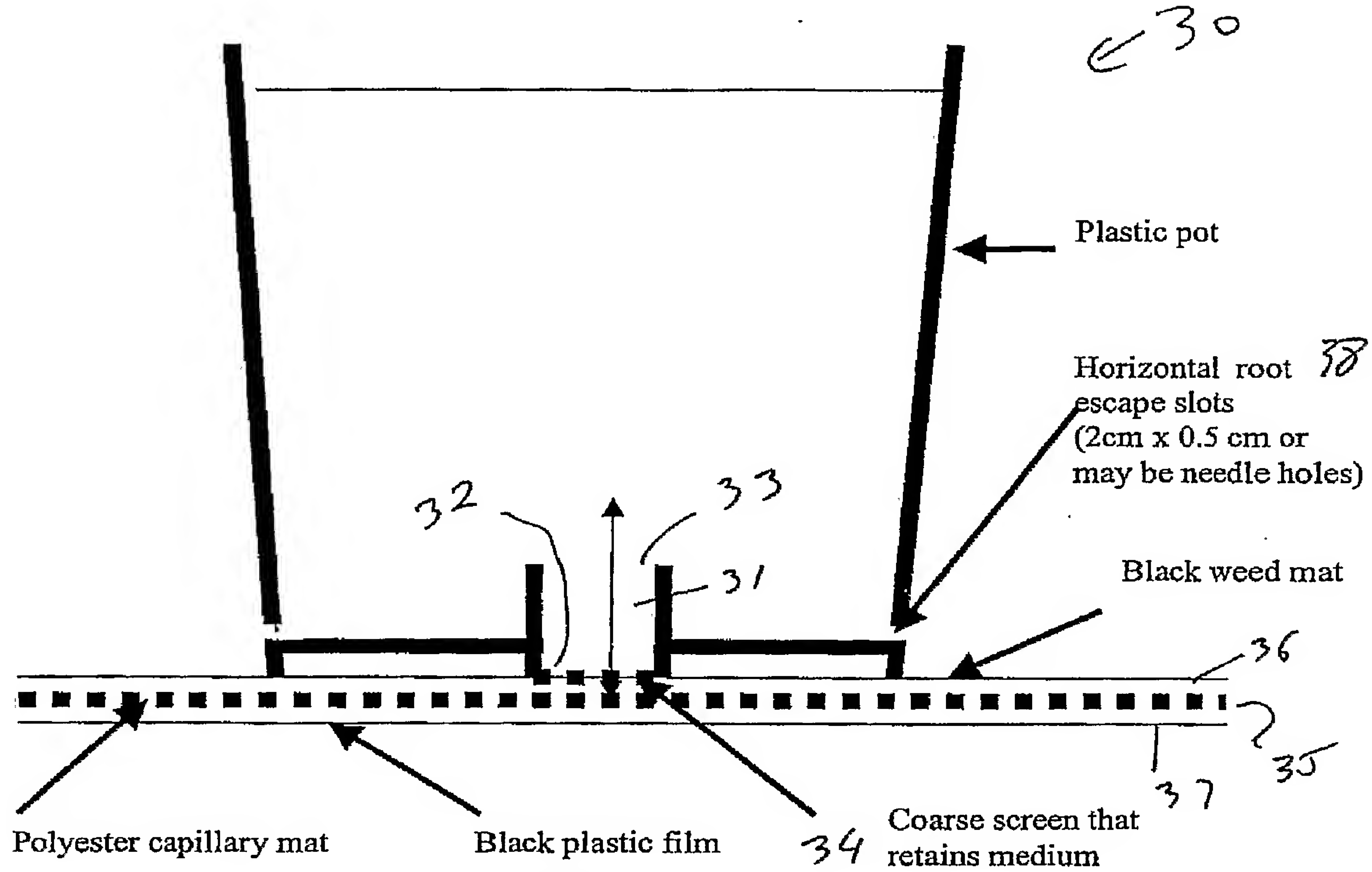


FIGURE 2

Benefits

- More predictable water uptake (much less interference from roots)
- Opportunity for basal roots to be air pruned
- Roots less likely to enter capillary mat
- No use of chemicals to prevent algae or root growth
- Pot drainage less affected by root blockages

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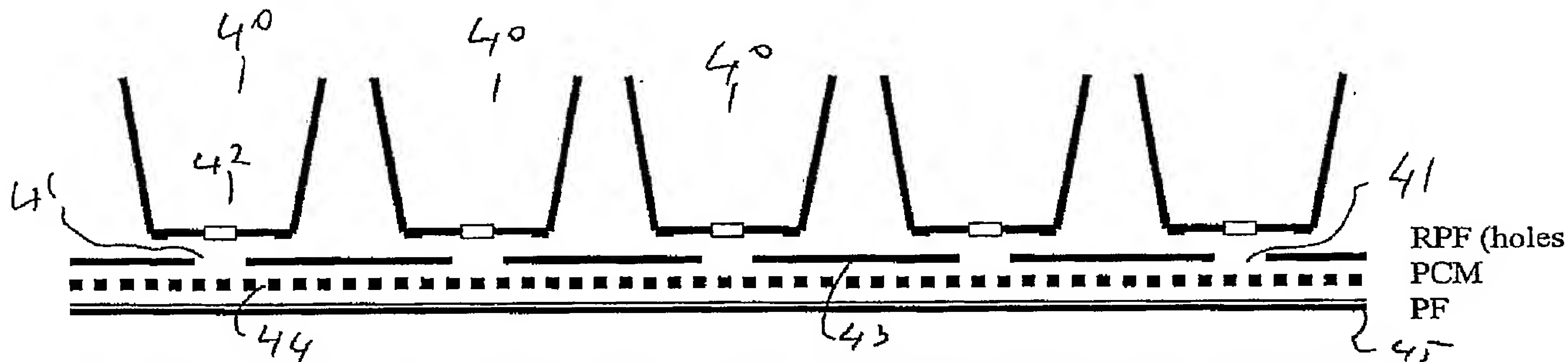
Capillary Mat Watering System Incorporating plug pots (exploded view)

FIGURE 3

Across Slope



RPF= Reflective plastic film with spaced holes; PCM= Polyester capillary mat; PF= Plastic film

Down Slope

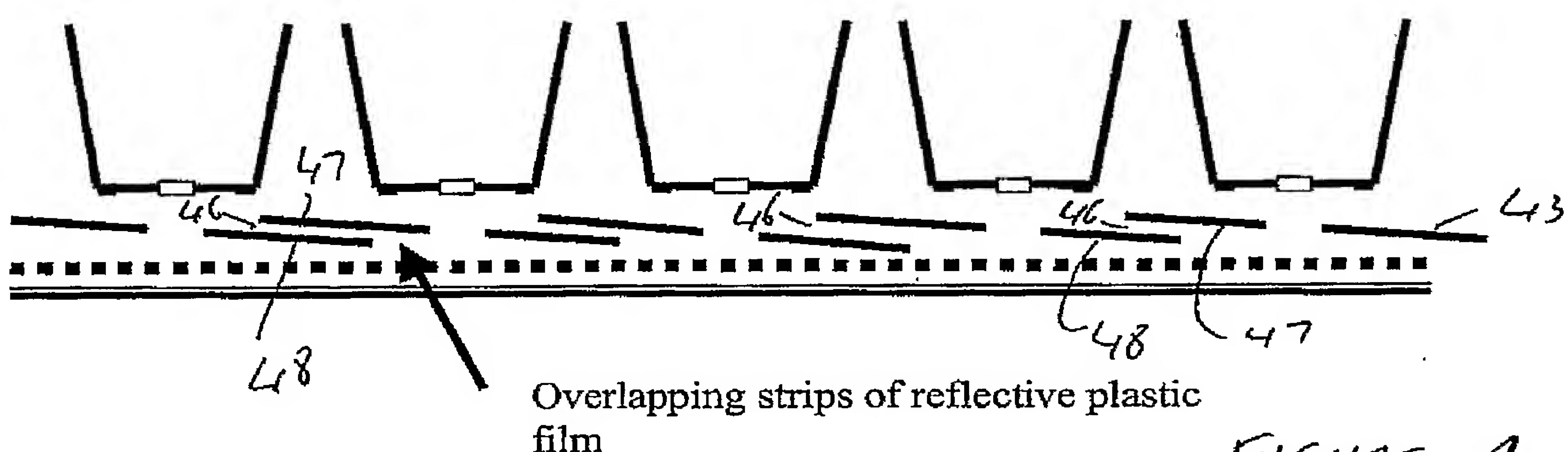


FIGURE 4

Above View

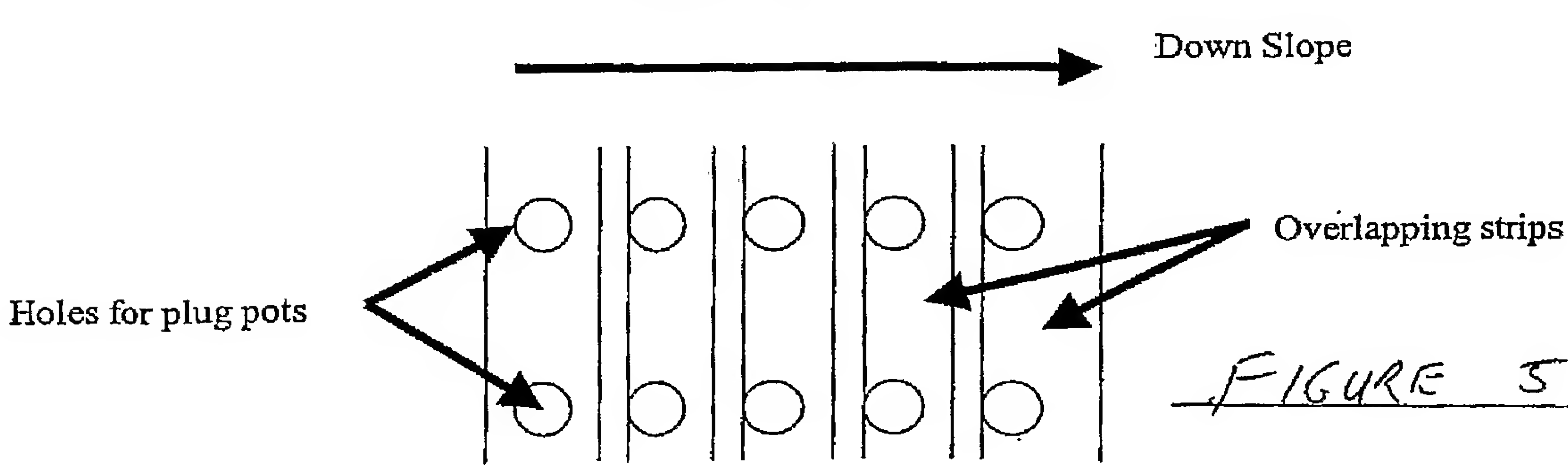


FIGURE 5

Irrigation water or rainfall will trickle between overlapping sheets and be stored in capillary mat for later uptake by plant. Overlapping sheets will prevent evaporation. Surface of reflective film will normally be dry preventing the growth of alga or weed seeds. Any roots emerging from side slots will be air pruned.

Root Control Watering/Drainage Tapes

FIGURE 6

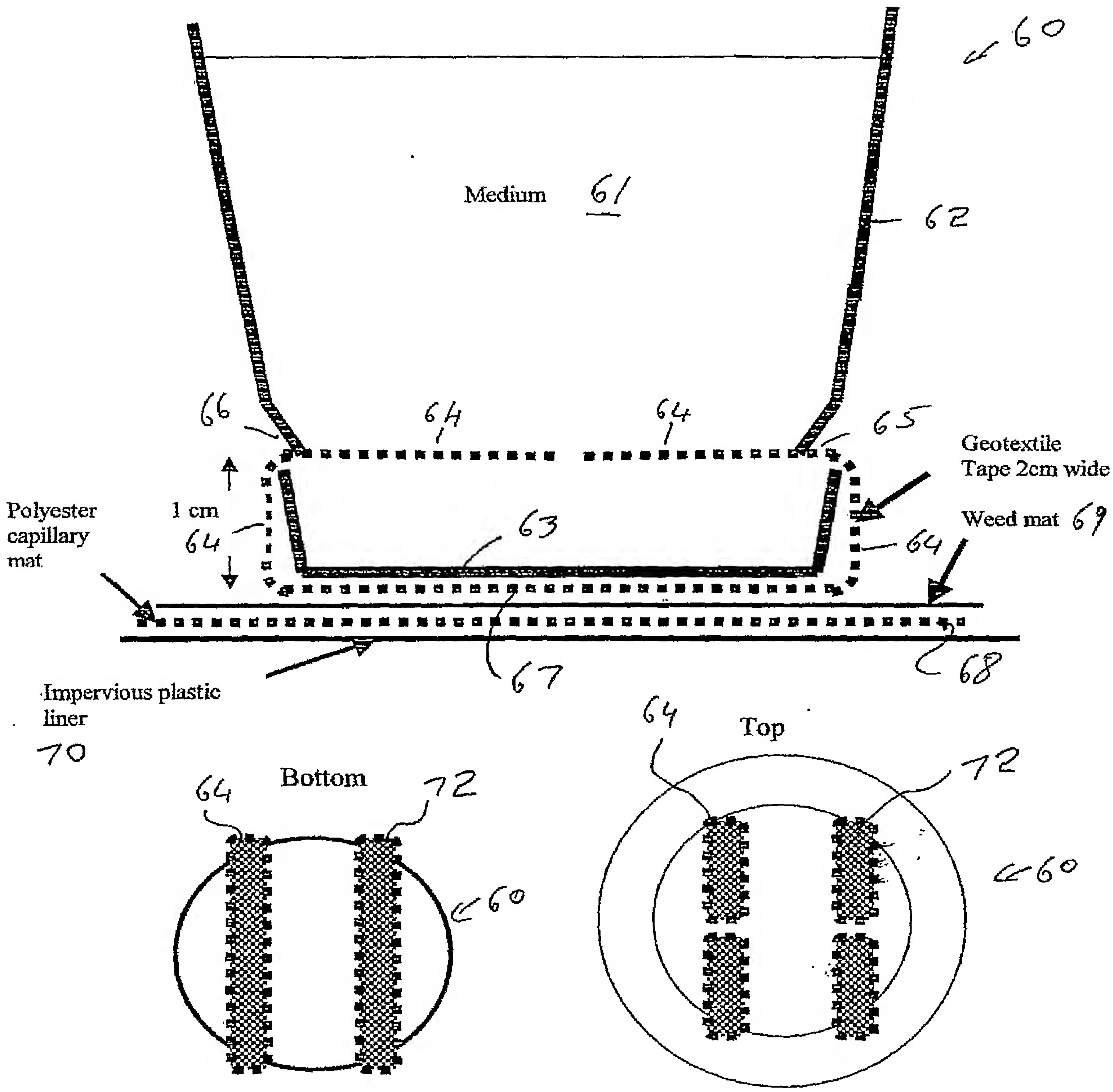


Figure 6A

Figure 6B